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SCIENCE

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FRIDAY, DECEMBER 23, 1898.

ZOOLOGY AND THE PHILOSOPHY OF EVOLUTION.*

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"I have nothing to say to any Philosophy of Evolution. * * * Attempts to construct such a philosophy may be useful, but in my judgment they are premature."—HUXLEY: 'Collected Essays,' V.

THE facts given in the last two lectures seem to show that we cannot expect much from the 'Lamarckian factors,' even if they should prove to be factors; and while this impression may be wrong, it seems to be the rational frame of mind until it has proved wrong.

He who follows the current literature of zoology finds that many writers assure him, in effect, that the years which Darwin and Wallace gave to hard labor on the problem of species were thrown away, since all they tried to find out by hard work might have been deduced from the Philosophy of Evolution.

We were warned, long ago, that "whoever, unable to doubt and eager to affirm, shall establish principles, and, according to the unmoved truth of these, shall reject or receive others, * * * he shall exchange things for words, reason for insanity, the world for a fable, and shall be incapable of interpreting."

In 'philosophy' current history is sometimes ancient history, and the ardent dis-

* One of a course of lectures on the Foundations of Zoology as delivered in Columbia University, December, 1898.

ciples of 'philosophers' who, in modest earnestness, undertake to formulate the scientific knowledge of their day often become bolder than their teachers, and, growing arrogant and reckless with success, find at last that they have sold their birthright in nature for what proves, when examined, to be no better than a mess of pottage.

The evidence that living matter is continuous, from beginning to end, is so conclusive that it convinces all who know its value. All living things are one by birth, and the system of living nature is, historically, a unit, a consistent whole—not a collection of isolated and independent species. How does it happen, then, that at every point in its history we find it divided into detached groups, separated by gaps and characterized by fitness? Why is the system of living nature such that we cannot picture it as a circle, spreading in all directions from a common center, and growing wider around its whole circumference? Why is it such that it is more exactly represented by a number of growing radii, independent at their outer ends.

This is the problem which Darwin undertook to solve, by showing that it results from extermination according to a standard of fitness. How does the Lamarckian meet it? Sometimes by denying the existence of fitness. Sometimes by asserting, even in the same breath, that fitness is universal and necessary, and that there is no real problem.

He asserts that it is the outcome or expression of a deeper principle of necessary progress or evolution, which must result in fitness. The tendency to regard natural selection as more or less unnecessary and superfluous, which is so characteristic of our day, seems to grow out of reverence for the all-sufficiency of the philosophy of evolution, and pious belief that the history of living things flows out of this philosophy as a necessary truth or axiom.

"The inheritance of characters acquired

during the life of the individual is an indispensable axiom of the monistic doctrine of evolution."^{*}

The writer yields to no one in admiration of the doctrine of evolution. So far as it is a scientific generalization from our knowledge of nature, it is one of the greatest triumphs of the human mind, rivalled only by its reciprocal, the doctrine of dissolution.

Experience seems to show, very clearly, that our system of nature is, on the whole, moving towards what commends itself to our minds as evolution, or progress to greater and greater perfection. While there is just as much evidence that each step in evolution is also a step toward dissolution, we have the same rational ground for expecting that this movement will continue, without any sudden radical change, that we have for other expectations which we base on knowledge of nature.

So far as the doctrine of evolution is based on knowledge, it is not only a part, but one of the most valuable and suggestive parts of the system of science, for the scientific law of evolution is part of science; but the philosophy of evolution is held by many as a creed, superior to and able to direct science. As men of science, we, like Huxley, have 'nothing to say to any philosophy of evolution,' except so far as it stands in the way of scientific progress.

We are sometimes told that while the other idols of which Bacon warned us are still worshipped, the idols of the theater have been deserted, and their temples abandoned; although he himself lays peculiar stress on their persistency.

"Lastly, there are idols which have crept into men's minds from the various dogmas of particular systems of philosophy, * * * and these we denominate idols of the theater. For we regard all the systems of philosophy hitherto received or imagined as so many plays brought out and performed, creating

^{*} Haeckel, 'Monism,' p. 96.

fictitious and theatrical worlds. Nor do we speak only of the present systems, or of the philosophy and sects of the ancients, *since numerous other plays of a similar nature can still be composed.*"

They who worship this modern idol of the theater hold that everything which has taken place and everything which can take place in our universe is deducible from the primal distribution of matter and energy. They tell us that everything in the past and everything in the future follows, of necessity, from this starting-point, inasmuch as it might all have been predicted; but while science knows laws—laws of evolution and others—it knows no necessity except the logical necessity for stopping when evidence stops.

The evolutionist tells us that if we start with a homogeneous universe, with all the matter uniformly distributed, and all the energy kinetic; and if any break in this indefinite unstable homogeneity exist or be brought about, all the rest must follow of necessity, as a matter of course, from the nature of things; that all things must go on along their predetermined course until all the matter shall have fallen into stable equilibrium, and all the energy shall have become latent or potential.

As no one can say the basis for all this is not true, and as it seems much more consistent with scientific knowledge than other systems of philosophy, we must admit that, for all we know to the contrary, it may be true; and we must ask whether, if true, it is any substitute for science; although we must remember that there is no end to the things which, while no one treats them seriously, may nevertheless be true.

All the fancies of the poets which do not involve a contradiction may be true; but while anything which is not absurd may be good poetry, science is founded on the rock of evidence.

Many have found the opinion that all

nature is conscious and endowed with volition, that the morning stars sing together, that the waters laugh, that trees talk, and that the wind bloweth where it listeth, worthy of belief; and it is clear that we cannot oppose any belief of this sort by evidence, or convert the sailor who believes that the wind obeys his whistle, by asking for proof.

The path of scientific progress is strewn with beliefs which have been abandoned for lack of evidence, as burst shells strew a battlefield, and it is our boast that they are abandoned, and not lugged along the line of march. As a shell which has failed to burst is, now and then, picked up on some old battlefield, by some one on whom experience is thrown away, and is exploded by him in the bosom of his approving family, with disastrous results, so one of these abandoned beliefs may be dug up by the head of some intellectual family, to the confusion of those who follow him as their leader.

So far as the philosophy of evolution involves belief that nature is determinate, or due to a *necessary law of universal* progress or evolution, it seems to me to be utterly unsupported by evidence, and totally unscientific.

This system of philosophy teaches that, for purposes of illustration, our universe may be compared to an unstable, homogeneous, saturated solution, which remains unchanged so long as it is undisturbed, but crystallizes when shaken. The process of evolution must be supposed to start with a disturbance or shock. Something, inherent in the nature of things or outside, must press the button; but matter and its properties do all the rest, just as crystallization follows from the properties of the solution. Even if all this is granted, it is not apparent that the mind of the evolutionist has any power by the aid of which it could deduce anything whatever from

homogeneity, even if it were present at the beginning.

There are homogeneous solutions of sugar and homogeneous solutions of brine, and no one without experience of similar facts has any way to tell what potencies are latent in a solution except by finding out. While we find no reason to suppose a homogeneous saturated solution has any power to initiate anything, we cannot think of it as inert. It is, as it were, alive with energy, and its inactivity is due to the exact balancing of all its powers. It is prepared to spring into energetic action the instant the bonds that chain it are broken by something that disturbs the balance and sets its forces free.

So, too, the primæval homogeneity of the evolutionist is imagined as instinct with world-producing energy, ready to evolve stars and systems and worlds and oceans and continents and living things and men, and all that is 'in the round ocean, and the living air, and the blue sky, and in the mind of man,' the instant it is set free; and so on to the end, which will come when all the energy has worked itself out in motion, and all the matter has found rest in stable equilibrium.

Unless he who worships this idol of the theater is prepared to assert that there is only one kind of indefinite incoherent homogeneity, and unless he knows, in some way of which men of science are ignorant, what sort of homogeneous solution our universe was at the beginning, the only way for him to learn what potencies are latent in it is to find out by studying their products. It is hard to see how he can deduce anything whatever from his necessary law of universal progress except what he discovers. If his premises are admitted, all he can deduce from them regarding our subject is that, if he finds natural selection, the potency of natural selection was latent in his solution.

The philosophy of evolution is of no more use as a substitute for science than any other system of philosophy, although it is, no doubt, not only the latest, but the most consistent with our knowledge of nature, and although it may, for all I know to the contrary, be true. All this fails to give it any value as a short cut to natural knowledge.

The true believer may say, however, that while our finite, imperfect minds may be unable to deduce anything from homogeneity, in the absence of knowledge drawn from experience, the outcome of the process must nevertheless be determinate. As it has all come out of the primæval homogeneity, he says this must have contained it all potentially.

I am no philosopher, but this does not seem obvious or necessary to me. Nature, as we know it, consists in the main of permutations and combinations. 'I do not know,' is one thing, and 'I do know not,' is another, even if some fail to discriminate.

"It is easy to perceive that the prodigious variety which appears, both in the works of nature and in the acts of men, and which constitutes the greatest part of the beauty of the universe, is owing to the multitude of different ways in which its several parts are mixed with or placed near each other."

When we say three dice *can* be thrown in only two hundred and sixteen ways, all we mean is that we *cannot* throw them in any other way. We cannot throw three zeroes, or three sevens, in any way with ordinary dice without changing the marks; but we cannot attribute to the dice any latent capacity for being thrown in any way, or any capacity to do anything whatever as dice, even after we have been informed by Haeckel that 'the real maker of the organic world is, in all probability, a tetrahedron.'*

* 'Monism,' pp. 27, 28.

Except for a few odd thousands of quintillions of permutations and combinations no others can be formed from twenty-six letters, and if Galileo means any more than this by his remark that all truth is contained in the compass of the alphabet ; if his words are more than figurative ; if he intends to assert that the potency of literature is latent in the alphabet, independently of an author—it seems to me, with all respect for Galileo, that he is talking nonsense; for while the production of a learned treatise by the fortuitous concourse of letters may not be impossible, all the books we know of have come about in another way.

Twenty-eight figures are required to express the number of distinct deals in whist. "If the whole population of the world, say one thousand millions of persons, were to deal cards day and night for a hundred million years," they might justify Sarah Battle's criticism of the game, but they would not in that time have exhausted one hundredth thousandth part of the possible deals.

It is not clear to me that combinations are latent in the things combined. In fact, the bearing of these things on the matter seems to be negative and passive, rather than active or positive.

It is not clear that, with all their latent potency, a pack of cards would ever evolve a single hand without a dealer ; but if a part of the universe, so trivial and insignificant, presents opportunities so boundless, the matter and motion of our universe may present to a dealer opportunities for universes without end, no one like another, I do not see how one can assert that anything in the material universe is necessary or predetermined, except so far as it is one among an infinite number of possibilities.

Huxley tells us that, "if the fundamental proposition of evolution, that the whole world, living and not living, is the result of the mutual interaction, according to definite laws, of the forces possessed by the mole-

cules of which the primitive nebulosity of the universe was composed," be true, "it is no less certain that the existing world lay, potentially, in the cosmic vapor ; and that a sufficient intelligence could, from a knowledge of the properties of the molecules of that vapor, have predicted, say, the state of the fauna of Great Britain in 1868, with as much certainty as one can say what will happen to the vapor of the breath in a cold winter's day."

The thoughtful reader will note that Huxley's assertion that, if this proposition be true, it is no less certain that the existing world lay, potentially, in the cosmic vapor is no admission that the proposition is true, or the deduction certain ; nor must we forget that the most notable and valuable characteristic of Huxley's teachings is the declaration, in all his works, of the truth that the scientific basis of our confidence in the order of nature is evidence.

Again and again, in words which are unmistakable, he tells us that, while we may have reasonable confidence what to expect from the vapor of our breath in a cold winter's day, we know nothing about it except what has happened. The scientific value of our confidence depends, he tells us, on the extent of our experience of the behavior of the vapor of our breath, and similar bodies, on a cold day, or under similar circumstances. As, in this case, our experience is pretty extensive, the deduction is safe and reasonable ; but when a young man who had passed his life in the tropics spent the night on top of a high mountain with my students he was so far from deducing anything from the frosty morning air that he was at first alarmed by the behavior of the vapor of his breath.

If Huxley is right ; if the logical basis for confidence in nature is evidence, it seems clear that no amount of knowledge can ever give it any other basis ; for nothing seems more obvious, or more strictly logical, than

our inability to deduce anything from a single experience. The burnt child may dread the fire as much as if it had been burned twenty times, but the only way for it to learn whether, and to what degree, its dread is wise and prudent, without passing through the slow and painful process of selection, is to get knowledge, for a single experience affords no basis for any logical process.

While the emotional value of a sensation is, no doubt, limited by inherited structure, and dependent, to some degree, on intensity, its objective value as knowledge is regulated in accordance with the statistical law of probability.

If the history of what we call *our* universe were complete from beginning to end; if everything which exists in it were reduced to mechanical principles, and traced back to primitive nebulosity, this history would be only a single experience in cosmogeny, so far as the history of universes is in question. If we were to find, somewhere, a second nebulosity we would not be able to infer anything, except from the worthless analogy of a single experience; nor would we be able to infer or deduce, from our own, anything, not already known, with more than reasonable confidence. If we were still ignorant of any part of our order of nature we should have no way to find out but the way we have now; and while our confidence in its stability would be reasonable and judicious it would not be necessary or absolute unless our experimental knowledge were also absolute.

It seems to me that the truth for which Huxley strives, and hits with imperfect aim, would be more correctly expressed by the statement that, if our knowledge of nature were to be made complete, from beginning to end, we should expect to find that our confidence in its stability had been reasonable and judicious, and wise through-

out, and that any other expectation would have been folly and suicide, bodily as well as mental, and that it is only in this sense that we could assert that it all lay potentially in the cosmic vapor.

It is not because I dread or fear the philosophy of evolution that I refuse to accept it, but because it is not yet proved. When it is proved I shall accept it with cheerfulness, for I most assuredly hold no belief which is inconsistent with it, although I fail to see how the reduction of all nature to mechanical principles could show that nature is determinate; for if exhaustive knowledge of 'primitive nebulosity' should sometime show that there is nothing in nature which might not have been expected, I cannot see how this could show why the things we expect should be the things which come about.

They who assert that complete knowledge would be fore-knowledge forget that, for minds like ours, the only source of knowledge, either complete or incomplete, is evidence; for evidence can tell us only what has happened, and it can never assure us that the future *must be* like the past. Even if we knew all that has happened, from the beginning down to the present moment, we should have to regard the unknown remainder as equal, in all probability, to the known past. To my mind, Jevons' demonstration that if certainty be represented by unity the utmost confidence we can ever reach by complete knowledge can never exceed a value of one-half seems conclusive; but even if it be increased until it differ from certainty by less than any assignable quantity it must still remain nothing but reasonable confidence.

There may be some unknown reason why the stone which I set free from my hand shall fall, and it may be that, as my mind has been shaped by natural selection, I am unable to expect anything else than that it shall fall; but science affords no evidence that its

fall is necessary or predetermined ; for most thoughtful students assure us that the inductive study of nature tells us nothing about it, except that, so far as we know, all stones so placed have fallen according to Newton's laws, and that we have not the smallest reason to expect that any stone so placed will act differently ; nor, so far as I can see, would prove that all nature is mechanical, from beginning to end, be inconsistent with belief that everything in nature is immediately sustained by Providence ; nor am I able to see how it would be inconsistent with my conviction that my volition counts for something as a condition of the course of events.

I have tried to show that, while the responsive activities of living things do not take place unless they are called forth by a stimulus, the things which they do under a stimulus are no more than their organic mechanism would lead one to expect, and that there is no necessary antagonism between those who attribute the development of the germ to mechanical conditions and those who attribute it to the inherent potency of the germ itself.

I have also tried to show that there need be no more antagonism between those who attribute knowledge to experience and those who attribute it to our innate reason ; for, while knowledge does not arise in our minds without a sensible occasion, the knowledge which does thus arise may be no more than one who knew the whole natural history of our minds might have expected.

We must now ask whether proof that all nature was latent in the cosmic vapor would be inconsistent with the belief that everything in nature is immediately intended rather than predetermined.

Certain monists tell us that the scientific doctrine of evolution is the same as Pantheism, for "since the simpler occurrences of inorganic nature and the more complicated phenomena of organic life are alike reduci-

ble to the same natural forces, and since, furthermore, these in their turn have their common foundation in a simple primal principle pervading infinite space, we can regard this last [the cosmic ether] as all-comprehending divinity, and upon this found the thesis: Belief in God is reconcilable with science."*

They who agree with Haeckel may worship stones, if they see fit ; but they seem to me to fail as completely as any South Sea Islander to understand the nature of scientific evidence ; for it is one thing to find sermons in stones, and quite another to see a divinity in the stone itself, ' which, if with reason, we may do, then let our hammers rise up and boast they have built our houses, and our pens receive the honor of our writings.' But everything must be determinate, says the pious evolutionist, or what would become of the fixed order of nature ? Among the things that occupy the biologist are such aspects of nature as life, and consciousness, and volition, and reason, and right and wrong. Whatever these things mean, they are part of nature, and the zoologist cannot push them out of sight if others may. He does not know what their places in the system of nature are, but he would like to find out ; and he knows no way to find out except to discover.

When they who worship at the shrine of evolution tell him there can be no spontaneity in nature, because the order of nature is fixed and unchangeable, he asks what reason there is for thinking that proof that everything in nature is mechanical, and no more than might have been expected, would show that anything is fixed, or predetermined, or necessary.

Science has nothing to do with the notion of 'necessity,' and is quite content to leave it in the hands of its originators, the metaphysicians and theologians and 'philosophers,' who alone are responsible for all the mental confusion it has brought about.

* Haeckel, 'Monism.'

What the man of science asserts is that he will not admit that anything is 'arbitrary.' "It was the ignorance of man's reason that begat this very name, and by a careless term miscalled the Providence of God; for there is no liberty for causes to operate in a loose and straggling way."^{*}

Belief that everything in nature is mechanical is neither more nor less than belief that everything in nature is orderly and what might have been expected; and if any one thinks that discovery that things do take place in order is any reason why they should, his distrust of science is only reasonable; for science is not for such minds as his.

It is in my mind to ask a question. Will any amount of knowledge of matter and motion tell the evolutionist whether I shall ask it or pass it by and go on to another subject? If he answer Yes I ask my question: How does he know? If he assure me that a being so reasonable as I am known to be will not ask anything that might not have been expected I thank him for the compliment, for I try to be a reasonable creature. But if he assert that his confidence in my thoughts and actions proves that they are *necessary* I must ask him how he knows; for I fail to see how proof that an event is mechanical and neither less nor more than might have been expected shows that it is *necessary*; nor can I see any more reason why my confidence in my freedom proves that my acts are *arbitrary*.

The man of science quarrels with no man's opinions, but he will not be held responsible for perplexities which are none of his making.

I am unable to share the dread of the evolutionist that the basis of science may be destroyed if we do not admit that all nature must be determinate. All agree that the past is determinate, so far as the word means anything to us, and there seems to

be valid ground for the belief that every part of the material universe contains a permanent record of every change which has ever occurred in any part.

"If on a cold polished metal, as a new razor, any object, such as a wafer, be laid, and the metal be breathed upon, and, when the moisture has had time to disappear, the wafer be thrown off, though now the most critical inspection of the polished surface can discern no trace of any form, if we breathe once more upon it, a spectral image of the wafer comes plainly into view, and this may be done again and again. Nay, more, if the polished metal be carefully put aside, where nothing can deteriorate its surface, and be kept so for many months, on breathing upon it again the shadowy form emerges. A shadow never falls upon a wall without leaving thereupon a permanent trace, a trace which might be made visible by resorting to proper processes. Upon the walls of our most private apartments, where we think the eye of intrusion is altogether shut out, and our retirement can never be profaned, there exist the vestiges of all our acts."^{*}

Babbage has pointed out ('Ninth Bridgewater Treatise,' pp. 113-115) "that if we had power to follow and detect the minutest effects of any disturbance each particle of existing matter would furnish a register of all that has happened. The track of every canoe, of every vessel that has as yet disturbed the surface of the ocean, whether impelled by manual force or elemental power, remains forever registered in the future movement of all succeeding particles which may occupy its place. The furrow which it left is, indeed, instantly filled up by the closing waters, but they draw after them other and larger portions of the surrounding element, and these again, once moved, communicate motion to others in endless succession. The

* Religio Medici.

* Draper, 'Conflict of Science and Religion.'

air itself is one vast library, in whose pages are forever written all that man has said or even whispered. There, in their mutable but unerring characters, mixed with the earliest as well as the latest sighs of mortality, stand forever recorded vows unredeemed, promises unfulfilled, perpetuating in the united movements of each particle the testimony of man's changeful will."*

So far as we know, nothing that has ever been can be as if it had not been; and we seem to have good ground for believing that every portion of the material universe contains a record of every change that has taken place in all its parts, and also for believing that there is no limit to the power of minds like ours to read and interpret this record. Every new experience also shows that our expectation that the future will, on the whole, be like the past is reasonable. In these facts science finds a basis broad enough and firm enough for all our needs; for to this extent the data of science are latent in the physical universe, even if the future is, in part, to be what man and other living things make it.

If these evolutionists who hold that all nature is determinate and necessary are right, mind would seem to be useless. It may, for all I know to the contrary, be true that when I perform an action because my reason approves it neither the performance of the action nor the approval of my reason is anything more than exhaustive knowledge of the mechanism of my brain might have led one to expect; and if it follows that my action is necessary, and must take place, whether my reason approve it or not, reason would seem to be useless; but I cannot see why this should follow, for I fail to see how or why proof that my reason is mechanical and no more than might have been expected from my structure should be inconsistent with my confidence in its value, since I

cannot conceive how this proof could show that it is necessary, or predetermined, or useless.

I know the value of my reason by what seems to me the best of all evidence. If it were proved useless I should be quite ready to believe; but the improbability of this opinion seems to me so much like impossibility that I must ask for proof which is correspondingly conclusive; for I most assuredly refuse to give any weight to the 'faith' of pious evolutionists, and I must insist on my right to demand more evidence if more is to be had, for I cannot accept the mind of the evolutionist as a measure of nature.

Living things are continually bringing about rearrangements of matter and motion which would never, so far as I can see, have come about without them, and many of the things which they thus bring about are useful to the beings which bring them about. The earth would be very different in many respects if man had never inhabited it, and the effects of his activity will last as long as matter, whatever may be his fate. His influence upon the earth would have been very different if the plants of Carboniferous times had not stored up solar energy and worked their changes in matter millions of years ago. If the dodo, and the great auk, and the halicore, and the American bison, could tell their story they would bear witness that man is a factor in the order of nature.

They who are discontented with reasonable or 'moral' certainty, and tell us they want absolute certainty, must find this sort of certainty if they can and where they can, but their words seem strange to the zoologist. He knows that the rocks are full of the remains of organisms which passed out of existence because they were born in evil times, when the adjustments to the order of nature, which had served the purposes of their ancestors for millions of years, ceased to hold good.

* Quoted by Jevons, 'Principles of Science,' p. 758.

If our race should ever find itself where the old order changes ; if our reasonable expectations should disappoint us ; if what we call the 'order' of nature should prove to be no more than natural selection would lead us to expect, and if a different selective standard should sometime modify this order, every zoologist knows that the human species would not be the first to meet this evil fate.

If, with Aristotle, we believe 'that is natural which holds good,' if, with Erigena, we hold that nature is the sum of all things, we cannot believe that life and consciousness and reason and volition are anything but part of nature. The question the zoologist would like to answer is what their place in nature is. So far as I am aware, no one believes that these aspects of nature exist in themselves, without antecedents, for we know that many of their antecedents are physical, and we want to find out, if we can, whether this is true of all of them or not. For my own part, I fail to see what bearing this wish has on the question whether the order of nature is 'fixed' or unfixed ; nor can I see how proof that the conditions which, being given, are good reasons for expecting reason or the moral sense are mechanical should show that reason and morality are useless.

They who take refuge in an imponderable ether as soon as they find it difficult to discover, in ponderable matter, the key to all the antecedents to certain phenomena of light and electricity have no reason to cry out that the fixed order of nature is threatened, because the modest zoologist has not yet been able to find, in ponderable matter and physical energy, the key to all his problems.

Berkeley tells us that human knowledge has its basis in experience, and that its scientific value is to be measured by the amount of this experience ; and Huxley assures us that there is but one kind of

knowledge and but one way to acquire it. They hold our practical test of truth to be evidence, although a pious evolutionist, who admits that, for all he knows, they may be right, is a heretic ; for Herbert Spencer tells him that the Philosophy of Evolution stands or falls with the assertion that the ultimate criterion of truth is inability to conceive its negative.

If you will read Part VII. of his 'Principles of Psychology' with care you will note that its author tells us that unless we admit this we cannot be his disciples. It is not enough to admit ignorance of things ultimate, or to confess that, for all one knows, inability to conceive its negative may sometime prove to be the ultimate criterion of truth. One may admit that he is unable to discover any line which separates the responsive actions of living things in general from the rational actions of thinking men ; that he does not know how or where instinct and impulse and emotion give place to reason. One may have as little faith in the idealism of Berkeley as he has in Spencer's realism, or in the materialism of German physics, or in the monism of the psychologists ; but unless he knows what the relation between mind and matter is he cannot join the throng of worshippers before the shrine of this modern idol of the theater, for its leader tells him that suspension of judgment on this difficult question is as fatal as disbelief.

Proof that we should not be here if our remote ancestors had not responded to the order of nature as they did is no proof that our minds are a measure of nature, or that our responses will be valuable in the future, or that nature is determinate.

Now the difference between belief that the ultimate test of truth is the inconceivability of its negative, and belief that our practical test of truth is evidence, is this : that while inability to conceive the negative of a proposition may be absolute to us, as

nature has made us, at our present intellectual level, evidence is progressive, and can afford no basis for ultimate philosophy.

Our pre-Cambrian ancestors may have been unable to conceive the negative of many propositions, but what does the inability of a turnip or a sponge to conceive the negative of Newton's laws signify? Or what would our own inability signify if we should sometime find out that the ponderable matter which makes up what we call 'our universe' has been sifted out or segregated from other forms of matter by its property of weight? For no less distinguished an authority than Herschel held that there is proof of the existence of levitative matter as well as gravitational matter.

One volume of Herbert Spencer's 'Philosophy' is devoted to proof that we primarily know objects, but to this long argument Berkeley answers: Granted. Most assuredly we primarily know objects, but he tells us that the objects we know primarily are objects of sense.

So the frozen river of philosophy grinds on, scratching the surface of the everlasting hills, and melting before the genial sunshine of science, only to receive new accretions from the unknown and frozen space beyond the snow-line.

Some fifteen hundred years have passed since we were told by Proclus that "there are two sorts of philosophers. The one placed body first in the order of beings, and made the faculty of thinking depend thereupon, supposing that the principles of all things are corporeal; that Body must really or principally exist, and all other things in a secondary sense, and by virtue of that. Others making all corporeal things to be dependent upon Soul or Mind, think this to exist in the first place and primary sense, and the being of Bodies to be entirely derived from and to presuppose that of Mind.*

* Berkeley, 'Siris,' p. 263.

While the modern psychologist tells us that there is a third point of view, and that, for all we know to the contrary, both mind and matter may ultimately prove to be phenomenal; that all mind may be matter in motion, and all matter in motion mind, or at least the raw material of mind, I cannot see why the admission of this possibility compels us to take a side and make a choice; for may we not find a fourth alternative, in a humble confession that, while we do not know what the relation between mind and matter is, we wish to find out? "And, although it may, perhaps, seem an uneasy reflection to some that, when they have taken a circuit through so many refined and unvulgar notions, they should at last come to think like other men; yet, methinks, this return to the simple dictates of nature, after having wandered through the wild mazes of philosophy, is not unpleasant. It is like coming home from a long voyage: a man reflects with pleasure on the many difficulties and perplexities he has passed through, sets his heart at ease, and enjoys himself with more satisfaction for the future."*

If the antecedents to consciousness are outside consciousness it seems no more than natural that we should be unconscious of them; and the zoologist who admits that he does not know whether they are or are not all to be found in that part of the universe which may be made manifest to sense does not feel guilty of a threat to the fixed order of nature, or to anything or anybody else.

There are two reasons why biology and the 'Philosophy of Evolution' should be associated.

In the first place, there is a wonderful analogy between the problems of the sensible universe and the unfolding of the latency of the germ into the potency of the fully developed living being. It is not impossible that the key to the more specific

* Berkeley, Preface to 'The Three Dialogues.'

problem may fit the lock which seals the greater.

In the second place, the two subjects are historically associated. So long as men believed that species are distinct creations, no philosophy of evolution could have gained general acceptance. By convincing all thoughtful persons that species have a history which may be studied by scientific methods, Darwin led many who would not otherwise have given it a hearing, to treat the new philosophy with respect, but natural science is not 'philosophy,' notwithstanding this intimate historical connection between the proof that species are mutable and the spread of belief in the 'Philosophy of Evolution.' I have selected the passage which I have put at the head of this chapter, in order to show that the view of the matter which is here set forth is not new, even among advanced biologists.

Huxley's attitude will, no doubt, be a surprise to many who think they have read his books with diligence. He continually calls himself an 'Evolutionist,' and he can hardly blame a reader who, failing to draw nice distinctions, holds him to be one of the chief pillars in the temple of the new philosophy. Some confusion may be permitted to those who remember his public lectures on 'Evolution,' his essays with the same title, and his declaration that the work of his life has involved him 'in an endless series of battles and skirmishes over evolution.'

It is easy for one who understands his true position to see that his essays lend no countenance to the opinion that he has ever been or sought to be either a pillar or a disciple of any system of philosophy, for he has never ceased from affirming his ignorance of many of the subjects which philosophy seeks to handle.

His evolution is not a system of philosophy, but part of the system of science. It deals with history—with the phenomenal

world—and not with the question what may or may not lie behind it.

During the last half century natural science has become historical. We have opened and learned to read a new chapter in the records of the past. The attributes of living things, which seemed to the older naturalists to be complete and independent in themselves, have proved to have a history which can be studied by the methods of science. They have been found to be steps in a long sequence of events as orderly and discoverable as the events which are studied by the astronomer or the geologist.

The cultivation of natural science in this historical field, and the discovery that the present order of living things, including conscious, thinking, ethical man, has followed after an older and simpler state of nature, is not 'philosophy,' but science. It involves no more belief in the teachings of any system of philosophy than does the knowledge that we are the children of our parents and the parents of our children; but it is what Huxley means by 'evolution.'*

His lectures on 'Evolution' deal with paleontology, and narrate facts which are found in every text-book on the subject; but natural science, as it is taught in the text-books on botany and zoology and embryology and paleontology, is, most assuredly, no 'Philosophy of Evolution.' It fell to Huxley to fight and win a battle for science; and while he himself calls it a battle for evolution, his use of the word need mislead none, although it has misled many.

One word in its time plays many parts, and the word 'evolution' has had many meanings. To-day, in popular estimation, an evolutionist is not a follower of Bonnet; nor one who is occupied with the binomial theorem, or with the evolutions of fleets

* See Huxley, 'Essays,' V. i., pp. 44-54.

and armies. Neither is he a cultivator of natural science. Whatever the word may have meant in the past, it has, in common speech, come to mean a believer in that philosophy of evolution which, according to such evolutionists as Huxley, is 'premature.' Since this is so, and since the growth of language is beyond individual control, would it not be well for them to stand where Huxley stands, and 'have nothing to say to any philosophy of evolution,' to stop calling themselves 'Evolutionists,' and to be content with the good old name of 'Naturalist?'

To the pious evolutionist, who asks what will become of the fixed order of nature if we are not convinced that everything is determinate, we answer that, while this sort of reasoning is not new, it has a strange sound in the mouth of a student of science. The order of nature has outlasted many systems of philosophy, and it may survive others. We have found our astronomy and our geology and our law of the mutability of species, and none of the dreadful things predicted by 'philosophers' have come about. There may still be more things in heaven and earth than are dreamed of in 'philosophy.'

History warns us that, as the price of progress in science, all the idols of the theater, and all other idols, "must be abjured and renounced with firm and solemn resolution, and the understanding must be completely freed and cleared of them, so the access to the kingdom of man, which is founded on the sciences, may resemble that to the kingdom of heaven, where no admission is conceded except to children."

If the world thinks hard names are the just due of them who assert their living wish to know, while humbly confessing ignorance, the biologist must bear up as well as he can if he is called a 'scientific Rip Van Winkle,' or an 'agnostic,' or even 'a turbaned and malignant Turk.'

If we seek admission to the temple of

natural knowledge naked and not ashamed, like little children, hard names cannot hurt us, nor need they scare us.

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*FERMENTATION WITHOUT LIVING CELLS
AND SYNTHETIC PROTEIN.*

I TAKE pleasure in complying with the request of the Editor to furnish the readers of *SCIENCE* with a brief abstract of the papers read at the late Vienna Congress by Professor Buchner, of Tübingen, and Dr. Lillienfeld, of Vienna, on 'Fermentation without Cells' and 'The Synthesis of Albumenoids,' respectively. The paper of Professor Buchner was presented to the whole Congress on the occasion of the first general meeting, July 28, 1898. The paper was illustrated with numerous experiments showing the production of vigorous fermentation within the time occupied by reading the paper, secured by ferments entirely free of yeast cells. The active principle of the yeast cells is obtained by grinding the yeast with quartz sand, for the purpose of disrupting the cells, and subsequently submitting the moist mass to a high pressure, *viz*: 500 atmospheres. Nearly all the yeast cells are disrupted by this process, and a microscopic examination of the residue discloses the empty cells from which all liquid contents have been removed. A more complete evacuation of the contents of the cells is secured by breaking up and moistening the press cake and repeating the grinding and pressure. About half a liter of liquid is obtained from a kilogram of yeast. The liquid contents of the cells, as they come from the press, are filtered through fine paper, in order to remove any danger of whole yeast cells being found in the extract.

The resultant liquor is clear or slightly opalescent, has a yellowish color and the pleasant odor of yeast. It contains con-